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QUARTERLY REPORT

Project Title: Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation

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Public Page for Quarter Ending June 27, 2010

Project #294: Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation

Background

Hydrogen is being considered as a promising candidate for alternative fuels. One key component of the hydrogen infrastructure is the delivery systems from the point of production to the point of use. Transporting gaseous hydrogen via existing pipelines is recognized as one of the most cost-effective options for delivering large volume of hydrogen. One of the major safety concerns has been performance degradation of pipeline materials under a high-pressure hydrogen environment. With extended exposure to high-pressure hydrogen, the mechanical properties of pipeline steels, including their tensile and yield strengths, fracture toughness, and crack-growth rate, may deteriorate. This could lead to significant reduction of service life of pipeline. As more and more high-strength pipelines have been put into service, there is a need for materials performance data under high-pressure hydrogen environment for high-strength steels. This project is intended to address these challenges. The objectives of this project are to produce performance data for high-strength steels used in hydrogen pipelines, use mechanistic-based analysis procedures and models for correlating the test data and predicting material behaviors under practical conditions. The test data and the analysis results will be used to enable updates and revisions of relevant industrial codes and standards.

Progress in the Quarter

The project activities undertaken in the third quarter included a number of new developments on project management. Progresses have been made in Task 1, Model Development, Task 2, Development of Test Equipment, Task 3, Fixture and Specimen Machining, and Task 4, Test Matrix Design.

Since the addition of Louis Hayden to the core project team during last quarter, the technical and deliverable payable milestone schedule, the budget for federal fund and cost-share need to be changed. Subsequently a contract mod request was made to DOT. The contract mod documents are currently under DOT review. CRES and NIST are close to completing their subcontract, therefore, NIST soon will be ready to get federal fund and formally start their project work.

CRES is further investigating simple 1-dimensional analysis models for fatigue crack growth rate under cyclic loadings. This type of analysis approach will be compared to mechanism-based model procedure to select an effective tool for fatigue test data correlation.

Tasks 2, 3, and 4 have been started at NIST. The designs of new hydrogen test chamber, the specimen, and the clevis have been completed. An elastic CMOD analysis has been conducted in accordance to the specimen design and ASTM E647 standards. NIST has used the analysis results to modify and finalize the specimen design.

The project team continued pursuing test materials from different industrial partners. As more testing materials are acquired, the project team continued the discussion of test matrix.